

# ASPHALT INSTITUTE

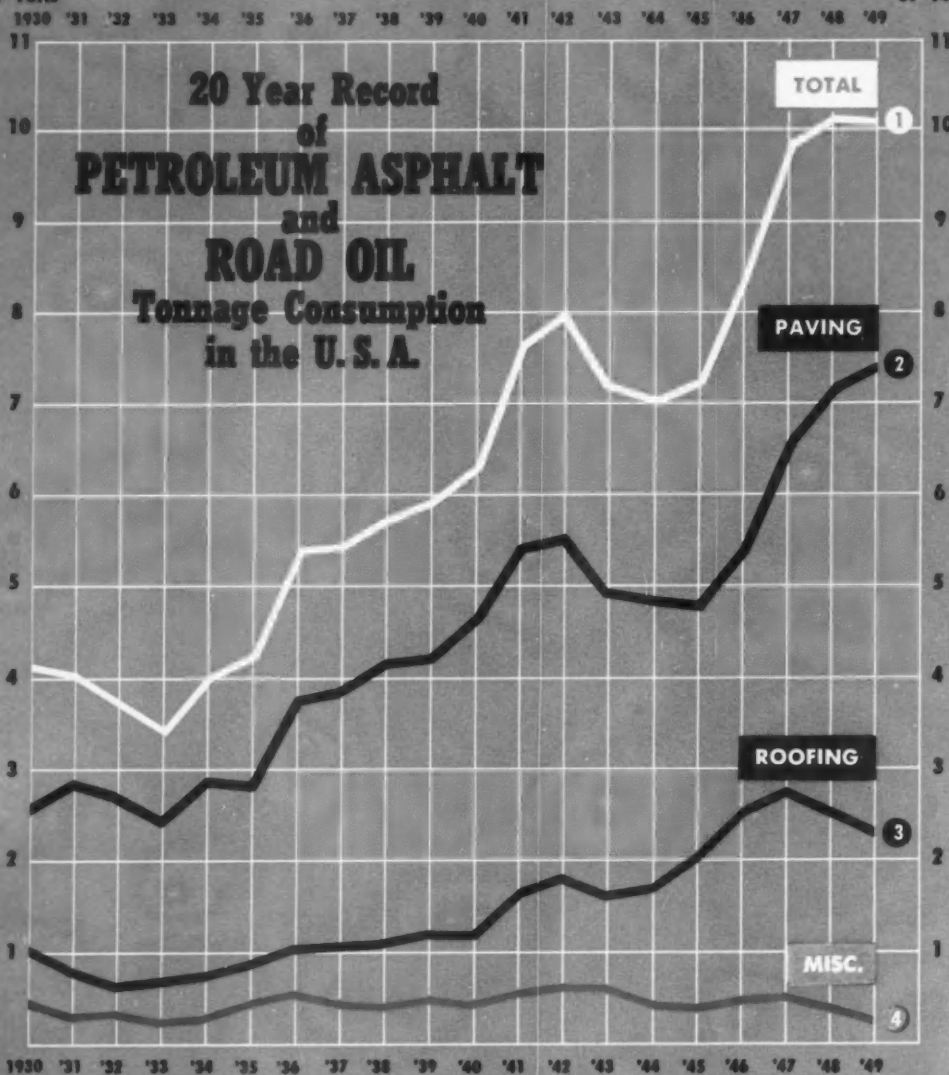
*Quarterly*

OCTOBER 1950

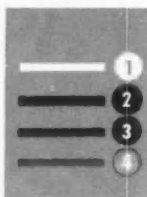


MILLIONS  
OF TONS

MILLIONS  
OF TONS



# KEY



- 1 TOTAL ASPHALT & ROAD OIL CONSUMPTION (=2+3+4)
- 2 PAVING
- 3 ROOFING
- 4 MISCELLANEOUS (INDUSTRIAL USES)

SOURCE: U. S. BUREAU OF MINES ANNUAL FIGURES  
CHARTED BY THE ASPHALT INSTITUTE OCTOBER 1950

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*Quarterly*

VOL. 2, No. 4

OCTOBER, 1950

The Asphalt Institute Quarterly is published by the Asphalt Institute, a national, non-profit organization sponsored by members of the industry for the purpose of promoting interest in the use of asphaltic products.

The names of the Member Companies of the Institute, who have made possible the publication of this magazine, are listed herein on page 15.

## EDITORS

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## COVER

Featured on the double covers is a 1950 construction operation on Oklahoma Route 74, in Garfield County, south of Covington, showing the aerating and compacting of a soil-asphalt base, which is to be twenty-four feet wide and six inches deep. Sufficient aeration must precede compaction to eliminate excess moisture and volatiles.

This twenty-year consumption chart illustrates the steady growth maintained, and how the totals, now in excess of ten million tons annually, are divided between paving, roofing and miscellaneous industrial uses. Since 1945, the paving tonnage has shown an accelerated growth.

## THE SUBGRADE CARRIES THE LOAD

The art of paving is a very old one. The remains of city processional streets, built thousands of years ago by civilizations that have disappeared long since, are evidence that the necessary engineering knowledge was available at an early date. Between cities, however, highways consisted almost entirely of the natural earth. Where soils were strong, the road was firm; where they were susceptible to moisture, the way was a maze of ruts and mud holes. To improve these poor sections it became the practice to place large stone, sometimes broken by hand sledges, in the attempt to provide better support. The improvement varied in quality according to the skill of the particular builder, but it was not until 1823 that a Scotch engineer, John Loudon McAdam, in his famous report to the Board of Agriculture, London, entitled "The Method of Making, Repairing and Preserving Roads," set forth the essentials involved in truly durable construction processes. The following quotation from that report is just as applicable today as it was over a hundred years ago.

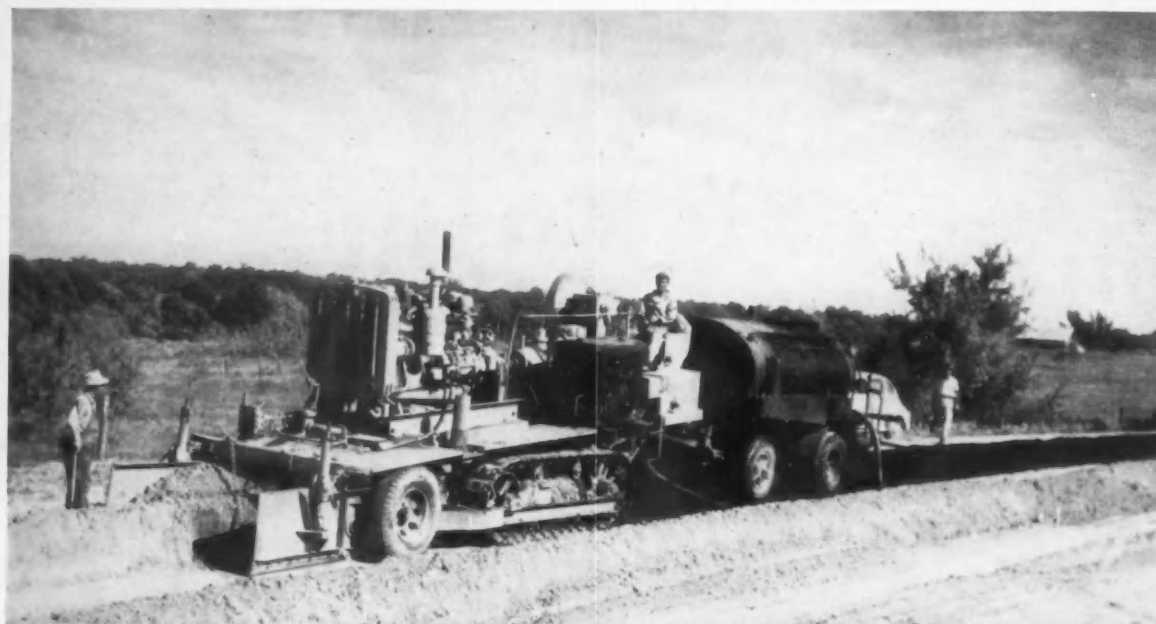
"The roads can never be rendered thus perfectly secure until the following principles be fully understood, admitted, and acted upon, namely, that it is the native soil which really supports the weight of traffic; that while it is preserved in a dry state it will carry any weight without sinking; and that it does in fact carry the load and the carriages also; that this native soil must previously be made quite dry, and the covering, impenetrable to rain, must then be placed over it, to preserve it in that dry state; that the thickness of a road should only be regulated by the quantity of material necessary to form such impervious covering and never by any reference to its own power of carrying weight.

"The erroneous opinion so long acted upon, and so tenaciously adhered to, that by placing a large quantity of stone under the roads, a remedy will be found for the sinking into wet clay, or other soft soils, or in other words, that a road may be made sufficiently strong, *artificially*, to carry heavy carriages though the sub-soil be in a wet state and by any such means to avert the inconveniences of the natural soil receiving water from rain, or other causes, has produced most of the defects of the roads of Great Britain."

McAdam devised a surface of crushed stone which is called "macadam" to this day. Such pavements, placed on a well-drained, compacted soil base, served very well indeed under slow-moving, iron-wheel traffic, and up to 1910, constituted a large portion of the improved mileage both abroad and in this country. With the increased use of the faster moving automobile, however, a stronger bond than stone dust became a necessity, and pavements mixed with bituminous or hydraulic cements were developed. The basic fact still remains, however, that a road is no better than its foundation and that the bottom layer of this foundation is always soil, or in engineering terminology—the subgrade.

Not only the layman but the engineer as well, too frequently has overlooked this fact, and during the twenties and thirties emphasis was placed on paving as the answer to highway needs. The so-called "permanent pavement" was to be the panacea for all ills, a bridge over the bad subgrades which would thus be safely covered forever. The current failures are being blamed on traffic, whereas they simply reflect defiance of basic principles laid down so ably over a hundred years ago by McAdam.

This issue of the Quarterly is devoted to a discussion of how potential supporting values may be developed through the use of *asphalt, the binding material most largely used in present day paving, whereby durable, waterproof surfaces may be provided at lowest cost.*



TRAVEL PLANT MIXING SOIL-ASPHALT NEAR MABANK, TEXAS.

## SOIL-ASPHALT ROADS

### HISTORY

The term "Soil-Asphalt" has come into use to define more exactly a variety of soil stabilization now again increasing in use at a rapid rate. Early experiments with this kind of work were undertaken about fifty years ago, when heavy petroleum products were used directly as an admixture with earth to produce an improved condition. The California counties were among the first to do extensive work in this regard, and Chris P. Jensen, County Engineer at Fresno, reported upon the practice in a paper before the Eighth Annual Asphalt Paving Conference in 1929. At that time, there were some 3,000 miles of soil-asphalt roads in this one county and a definite technique had been developed whereby the asphaltic oil was mixed with the earth at periodic intervals until a substantial depth had been secured. It is interesting to note that even in 1929, these roads were carrying a mixed traffic as heavy as 1,500 vehicles per day and that truck loadings of 22,000 lbs. on four wheels, and 34,000 lbs. on six or more wheels were permitted.

Shortly after the first experiments in California, the practice was adapted to the black soils of the Midwest, and a very considerable mileage was improved within a

few years. Along the Atlantic Seaboard work with sandy soils was started and in all areas marked improvement was secured, as compared with the untreated soil condition. There was, however, little or no control over the kind and quality of the oil while exact methods of soil appraisal were all but unknown.

Results, therefore, varied considerably from one job to another and, as the so-called higher types of paving were receiving increasing attention, more complete devel-

opment of soil-asphalt potentialities was delayed until recent years.

Present day knowledge of the science of soil mechanics permits engineers to appraise a soil *quite exactly* before construction. One of the best known methods of such soil classification is that developed by the federal Bureau of Public Roads, in which Hogentogler had such a notable part. Casagrande, of Harvard University, in his work with the U. S. Engineers, developed a system of soil appraisal which has many ad-

WILSON COUNTY, NORTH CAROLINA



OCEAN COUNTY, NEW JERSEY



LONG ISLAND



ON THE EASTERN SEABOARD MANY THOUSANDS OF ROAD MILES ARE OF SAND,

TREATED





Early distributor spreading road oil in Fresno County, California, in the twenties.

vantages. The U. S. Civil Aeronautics Administration likewise has developed a method used in the design of airport pavements. These constitute a most important advance in the science of soil evaluation, and from such studies is coming a realization that "just plain dirt" often may have all of the characteristics required for road foundations, and many times even for the surface itself, when intelligently treated and processed in a manner which will fully develop its potential supporting power.

It is high time that this new science of soil treatment be understood. In many areas the supplies of gravel and stone, which once seemed almost endless, are being depleted. Within another ten to twenty years bank gravel deposits will be utterly exhausted in many areas, while those remaining will be increasingly costly to employ. This is true throughout the entire North American continent. Even in New England, where thirty-five years ago glacial gravel seemed unlimited in amount, the best material has been removed in large part.

The river beds of the continent, upon which sand and gravel had been accumulating for years, likewise seemed a source of unlimited quantities of material, yet they too have been so drawn upon that in many instances dredging operations have been

abandoned, while others are on a day-to-day basis, hardly adequate for the areas immediately around them. When, in addition to these demands, there are added the requirements for the wide prairie areas which now must import aggregates from distant sources, one begins to have some realization of the absolute necessity for employing new kinds of aggregates — soils, if you please — in order that the demand for improved highways can be met, not only at reasonable cost, but if they are to be built at all.

### SOIL PROCESSING

The "processing of soils" falls into two general categories, depending upon the soil characteristics as appraised by established laboratory methods. These are as follows:

(1) Soils which are relatively coarse-grained in character and which contain but small amounts passing a 200-mesh sieve. Such soils include the sands along the coastal plains and in certain desert areas, together with the sandy loams widely distributed over all parts of the country.

(2) Fine-grained soils include the sand clays, clay-loams, and almost pure clay types, where 25% or more will pass the 200-mesh sieve.

The coarser grained soils are generally easy to process either by themselves through blending, where used as bases, or by admixture with asphaltic materials to provide both base and surface courses. The material being friable is easily reduced to particle size when it may be mixed and compacted to a uniform condition with but little difficulty.

Fine-grained soils are more difficult to process. Under favorable climatic conditions, however, pulverization of even heavy clay-types into lumps of not-too-large size, followed by mixing with asphaltic materials under carefully controlled moisture conditions, often will provide a satisfactory foundation for surface treatment. Considerable mileage of such work has been built, particularly in areas where freezing is not a factor, but for severe conditions of weather and traffic it is usually more economical to

modify a clay soil by blending with coarser soils, screenings, cinders, or similar materials before processing is attempted.

Processing can be done either on the roadbed, or by putting the material through a plant. There is still an attitude that, because soil is cheap, it does not justify processing under close control. In this connection it should be stated that any material, regardless of what it may be composed, which in the road will provide a foundation of the required stability and durability, is worth whatever processing may be required if the procedure has a lower cost than other methods. Crushed stone and gravel are valuable materials, and in many situations are the best products for the purpose. However, if the natural soil, with suitable processing, can be made to provide the needed load support, it is just as good in every particular as the best pavement so far designed. Fortunately this fact is increasingly recognized by highway engineers and accounts for the present rapid expansion of soil-asphalt surfaces.

Today there are the new types of travel plants which use liquid asphaltic materials as binder but which so pulverize the soil that very complete mixing is secured. It is believed that this is the logical equipment development for soil-asphalt construction.

### ASPHALT BINDERS

Asphaltic materials used in early mixed-in-place earth road processing consisted largely of slow-curing products, which are still used to some extent for light and medium traffic. With growing appreciation of the merit of controlled construction and the proven suitability of soil-asphalt for quite heavy traffic, there is a greater use of emulsified and cut-back asphalts for the purpose because of more rapid curing. The lighter products are employed for the soil-asphalt mixture itself, while the heavier grades are used for the seal or "armor coat" finish. Comment in this regard may be found in more detail in the articles which follow, and also by reference to the reports noted in the Bibliography at pages 6 and 7 herein.

### CONCLUSION

Modern highway design should recognize the value of utilizing selected soils as foundations and the fact that the correct approach is to build-up the foundations to needed support values rather than to thicken the wearing course to overcome weak soil subgrades. When this is done a rather thin wearing course to provide waterproofing and resistance to abrasion will be sufficient. As surfaces always cost more per inch of thickness than bases, it is plain common sense to adjust design so as to obtain the lowest possible total cost of the two elements. It cannot be repeated too often that in the final analysis *the subgrade must carry the load* and that processing this subgrade to its maximum strength is the best evidence of good engineering.

LONG ISLAND, NEW YORK



CAPE COD, MASSACHUSETTS



TREATED WITH EITHER CUTBACK OR EMULSIFIED LIQUID ASPHALTIC MATERIALS.

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*Note: The foregoing Bibliography includes important Construction and Research references to soil asphalt, so far as limited Quarterly space permits.*





## SOIL-ASPHALT ROADS IN OKLAHOMA

Single-pass mixing equipment attached to asphalt truck.

was bladed to each side to be used as a blotter, and penetration to approximately 2 inch depth was secured.

Analysis of soils was almost unheard of at that time, yet engineers were fully aware of the changing soil types in even a mile of road and to get more penetration in the tougher clay soils, a disk harrow was used to first pulverize the surface. Such work, consisting mostly of oil mats constructed by the mixed-in-place method gained immediate popularity. By the summer of 1932, production methods had so improved that local manufacturers were able to produce products comparing favorably with those recommended by the U. S. Bureau of Public Roads for medium curing liquid asphaltic types.

### LOCAL CONDITIONS

It is not unusual in Oklahoma to have yearly temperature variations of 120° F. accompanied by rainfall of from 15 inches to 70 inches, and with snow and ice covering three-fourths of the State area for periods as long as 45 days in duration. Oklahoma soils vary from the highly stable A-1 soil type grading down to the A-7 clays.

On the side of the State, east of Oklahoma City, there is a wealth of aggregate suitable for crushing and re-combining to produce satisfactory bases. On this side of the State too, are found the heavier types of sub-grade soils, with their consequent instability, together with the maximum rainfall that further adds to foundation difficulties. While considerable study has been given to processing of soils in this area, the aggregate type bases have performed so well that so far they appear to be the logical design for this area. Studies are being continued however, to prepare for possible future aggregate shortages.

On the west side of the State however, there is presented an entirely different picture. The soil is light, sandy, and more generally suitable for asphalt stabilization

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Sometimes selected soil is placed over weak subgrades.

Pumping asphalt to distributor from roadside storage tank.



Oklahoma, one of the largest oil producing states was an early pioneer in the construction of soil-asphalt roads, using local products. Beginning in 1918 and continuing until the summer of 1929, residual oils were used even on the State's main highways, pending opportunity to contract more durable surfaces. These so-called road oils were secured at local refineries, hauled to the job sites in the crude distributors of that period, and were thus placed only on roads within a short haul. They were of low viscosity, and indifferent quality, but were the only materials then economically available.

By 1929 however, a pronounced demand had developed for surfacing of an all-weather type on secondary roads and the first control specification for road oil was published by the Oklahoma Department of Highways. While naturally it did not meet our present day standards, it was a real advance in quality and yet permitted materials that could be manufactured locally and be low in cost. Treatment was by the so-called "penetration method" at the rate of approximately 15,000 gallons per mile 18' wide. A small ridge-row of loose earth



with minimum admixing or blending. Subgrade support is higher and more uniform and, in addition, construction is not subjected usually to the squally, violent and excessive rainfall of the eastern section.

With this physical picture confronting the Department, and in the absence of adequate deposits of natural gravel or aggregate that could be crushed, the aim has been to develop an efficient base through soil processing. Over several years, various maintenance sections were stabilized with asphalt using road-mix methods and careful record was made of costs and performance. This study led to stabilizing many additional sections using state-owned equipment and with the same satisfactory results. From this background of experience came our present procedure.

#### FIELD AND LABORATORY CONTROL

The object of soil-asphalt stabilization is to waterproof the finer soils to such an extent as will prevent capillary action and to increase the stability of the more granular soils by the cohesive qualities of the asphalt. To accomplish this, we treat the moist soil with medium curing cut-back asphalt of the MC-2, 3, and 4 grades. The lower viscosity grades are used with the finer soils to facilitate mixing, and the higher viscosity grades with granular soils to reduce time of curing.

When the soil-asphalt base is to be constructed on a roadbed previously built to standard grade and drainage, a new survey, including complete cross-sections, is made if the roadbed has been constructed more than two or three years. The survey notes are plotted on plan and profile sheets and a new grade line laid. These preliminary plans are transmitted to our Materials Department for use in making a soils survey and developing a soils profile.

A detailed soil survey of the project is made to determine the location of each type of soil. The soils are grouped into two classifications, (1) those naturally suitable for stabilization and (2) those where the soil either must be replaced or blended

with material to bring it into proper condition. California Bearing Ratio values are determined and select soil is added where they are too low. Borrow pits are located to provide such materials at convenient points near the project. Soil types suitable for stabilization then are tested to determine the correct proportions of water and asphalt.

Some moisture in a soil is desirable to facilitate blending. After mixing, it is necessary to allow the liquids, which include both the water and the volatiles in the asphalt, to cure out before compacting. Behavior under rolling will determine when the liquid content is sufficiently reduced for proper compaction. For a particular soil and weather condition, tests of the liquid content of the mix after successful compaction will give the information to be used as a guide in similar construction.

Each soil sample is air-dried, pulverized and passed through a No. 10 sieve. A sufficient amount of water is then added so that the soil will mix readily with asphalt. When the correct amount of water is present the soil appears fluffy. From 4 to 9 per cent moisture of the dry weight of soil will give this "Fluff Point." Next, to the moistened soil, is added 3 per cent asphalt, on weight basis of dry soil, as a first trial sample. Asphalt is added in successive sample series in increments of 1 per cent until a final sample is obtained which shows a definite excess of asphalt.

Mixtures are then air-cured until approximately one-half the volatile material is driven off. Four 2" x 2" briquettes then are prepared from each mixture under 10,000 pounds pressure in the Hubbard-Field Stability Machine. Two briquettes are tested at once for stability at room temperature, while the other two specimens are immersed in water for seven days to determine absorption and are then tested for Hubbard-Field stability.

We recommend proportions of asphalt and water, which may be easily mixed into the soil in the field, and that also show maximum Hubbard-Field stability after im-

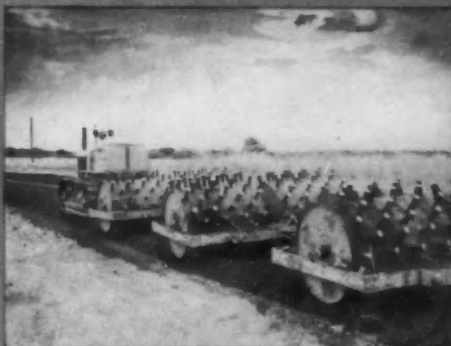
*Continued on page 10*



Aeration of mixture by disk harrows.



Aeration of mixture by pulvi-mixer and motor grader.



Compaction of mixture with sheep-foot rollers.

Final compaction with pneumatic rollers.





Six inch soil-asphalt road in Oklahoma constructed in 1930; photo 1950.

mersion in water, and low water absorption with minimum swelling.

Typical cross-sections of select soils subbase and soil-asphalt stabilized base of the thickness determined by laboratory tests for given sections of the roadway then are prepared and analyzed with a view to handling grading operations as economically as possible.

It is the practice in Oklahoma to pay for select soils for subbase or soil for asphalt stabilization by the 100' station when it is necessary to haul these select soils from approved borrow pits. For manipulation, which covers mixing the asphalt with soil, aerating the mix and shaping to the final section, payment is also made by the 100' station. Compaction is considered a separate item; while asphalt is paid for by the gallon.

The usual typical section of the soil-asphalt base is eight inches compacted thickness and twenty-four feet wide. If a subbase is required to develop a satisfactory bearing value as determined by the laboratory on the basis of California Bearing Ratio tests, thicknesses of from six inches to twelve inches are usually specified. The subbase material, which is a sandy material having sufficient fines to fill the voids so that a reservoir will not be formed at low points in the grade line, is constructed only to the twenty-four foot width of the soil-asphalt base. Quite often the roadbed material already in place is the type of soil that is satisfactory for processing, while in

other cases a sandy material must be hauled in and blended into the roadbed to produce soils suitable for stabilization.

Specifications for soil-asphalt stabilization require that traveling plants shall be used for the mixing of roadbed soil with asphaltic materials. They shall be of an approved type capable of accurately proportioning and thoroughly mixing the soil, bituminous material and water in the prescribed proportions, or in some cases of the type which measures only the bituminous material and incorporates it into the soil aggregate. In either case they shall be so designed that they will thoroughly mix the material and deposit them uniformly on the roadbed.

The specifications, control, and design procedure, used by the Oklahoma Department of Highways for the construction of soil-asphalt roads are the result of a long and satisfactory experience with this type of construction.

#### SATISFACTORY PROGRESS

Our continued observation and study of these roads has eliminated uncertainties and has led to a number of rules to be followed in selecting materials as well as procedures to be used in this type of work. It is our opinion that soils most satisfactory for stabilization contain not less than 50 per cent of soil particles retained on the 270 mesh sieve. Soils that approach 100 per cent sand will be difficult to cure out for compaction after the asphalt has been applied. The most desirable sand content, all

things considered, is from 65 per cent to 75 per cent.

The grade of asphalt used in most of our stabilization was MC-2, which is very satisfactory for the purpose. Recently, with the improvement in mixing equipment, MC-3 and MC-4 oils have been successfully used. The quantity of asphalt required to stabilize the Oklahoma soils will vary from 4 to 6½ per cent. Soils can be stabilized which require asphalt contents outside of this range, but the results so far are doubtful and it is deemed better practice to modify the subgrade by adding selected soils to produce a blend that will require 5 to 5½ per cent asphalt.

In 1949, it was felt that sufficient background experience had been had to justify going ahead on an expanded scale, and a contract construction program of approximately 200 miles of soil-asphalt stabilization work was undertaken. Closing our asphalt season on October 1st resulted in some of this mileage being carried over into 1950. This work, plus some 260 miles additional, is being completed during the 1950 season.

Our construction experience with this type of stabilization work has been quite satisfactory. While recent specifications provided for a single pass operation with traveling plants in an effort to eliminate as much personal equation as possible and to get away from any semblance of ordinary road-mix, these have been modified to permit the use of multiple pass machines, under certain favorable conditions. In the early stage of our program the contractors were confused and unaware of some of the problems encountered in laying the processed material after mixing. Experience soon developed that sufficient aeration must precede compaction to eliminate excess moisture and volatiles before effectively laying and compacting the soil-asphalt mixture.

After final compaction, a light prime coat is applied followed by a regulation armor coat treatment, after which the road is ready for use. One advantage of this type of construction is found in its adaptability to traffic. If volume increases over the years, the work already in place serves as a base for a new wearing course, thus making it a desirable type for stage development.



Application of aggregate to produce armor coat.



Twenty-four foot soil asphalt base ready for surface treatment.



Route 20 in Nebraska — 24' wide, 3" medium-curing cutback asphalt wearing surface on 8" natural sand base.

About one-fourth of Nebraska's 77,000 square miles lie in the sand-hill region of the State. The soil of this region is made up of wind-blown sands eroded in comparatively recent times, some of it still subject to shifting. Due to the weathering of the feldspars and minerals other than quartz, sufficient fine material is produced to give a loamy texture to the soil.

The gradation of the shifting dune sand is uniform with rarely less than 85 percent passing the No. 50 sieve, and with 2 to 5 percent passing the No. 200 sieve. The more stable loamy sands have from 75 to 90 percent passing the No. 50 sieve, and from 10 to 30 percent passing the No. 200 sieve. All of these are classified as A-3 soil type.

Early field experiments and subsequent laboratory research have demonstrated the need for using mineral filler in sandy-loam mixes when the material passing the No. 200 sieve is deficient in the natural soils. Fine silty friable soils, limestone dust, and volcanic ash have been used for that purpose.

The percentage of asphalt (which ranges from 4% to 6%) and the soils to be used in the mix are determined in the laboratory, using the Nebraska modification of the Hubbard-Field Stability Test.

#### CONSTRUCTION METHODS

Two general methods of construction have been employed in Nebraska in the stabilization of sandy soils with asphalt. In the *Blade-Mix Method* the preparation of the subgrade,

mixing, and finishing are accomplished with disks, harrows, pulverizers, and motor graders. In the *Traveling Plant Method*, motor graders are used for the preliminary preparation of the subgrade and finishing, and the mixing is done with a conventional type of traveling plant.

Early practice was to lay a mat approximately five inches thick in one course. Present practice is to design varying thicknesses depending upon traffic count, wheel loads and climatic conditions. Where thicknesses greater than three inches are employed the mat is laid in two or more courses, each course being thoroughly compacted and rolled with conventional types of compaction and rolling equipment.

Features that distinguish this work include close control of the quantities and type of asphaltic material used, and the amount and character of the minus 200 mesh fraction. Close attention, also, is given to aeration of the mixtures to remove moisture and the volatile fractions contained in the cut-back asphalts.

Efficient control of operations has produced high grade results, and proved the stabilization of sandy-loam soils with asphaltic materials both satisfactory and economical, with a definitely growing place in road construction in Nebraska. At the end of the present season the State's highways of sand-asphalt type will total six hundred and fifty-six miles, — an increase of 100% in the past 10 years.



The sand-hill road problem in Nebraska.



Processing the base for a sand-asphalt road.





A sand-asphalt surface on Florida Route 65.

## SAND-ASPHALT ROADS IN FLORIDA



Disk harrows were largely used in early mixing procedure.

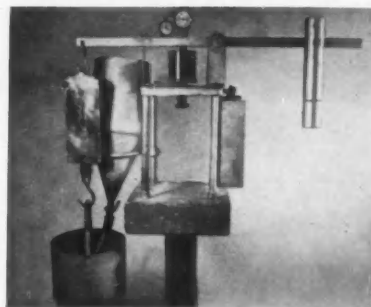


Present-day mixing, as accomplished by single-pass travel plants.

Florida's sand-asphalt pavements, using local soil mixed-in-place with rapid curing asphaltic materials, date from 1930 when the State Highway Department was responsible for construction of the first project. This pavement is still in service and the type of construction has proven so satisfactory and economical that the highway system of 9,235 miles now contains 1,180 miles of this type.

Refinements in design and construction methods have been developed during the past twenty years but the essential procedure of mixing the sandy soil on the road with a liquid asphalt, aerating and curing the mix to evaporate the volatiles, compacting and finishing the mix to a true section, and then sealing it with asphalt and sand has remained the same. Delays incident to early work with plows and harrows have been largely eliminated through use of travel plants which pick up the loose soil from the roadbed, apply the total quantity of asphalt, blend the two together, then spread and strike off the mix all in one pass of the mixer. A smooth tread tractor is run over the top of this mix to partially seal the surface against rain.

After a period of a few days, or in some instances months, the mix is resurfaced and aerated to permit final setting of the mixture. Proper aeration of the mix is a most essential step in the process. If the mixture is compacted when too wet, cracking will invariably occur. If the mix is worked too long, the volatiles will evaporate too soon and the mix will become unworkable. Proper compaction of the mix is obtained with a combination of sheepfoot rollers and rubber tire rollers but the surface is usually finished with a steel wheel roller weighing five to eight tons. An asphalt seal coat at the rate of 0.25 gallon per square yard is then applied and covered with sand. After some years' use, should noticeable wear occur, a reseat of asphalt and  $\frac{3}{8}$  inch slag may be applied.



Florida Bearing Test apparatus, to determine suitability of soil.

### FLORIDA BEARING TEST

When the mix on one of the early projects proved to be quite unstable because of the uniform particle size of the sandy soil aggregate, a laboratory bearing test was developed to pre-determine whether additional fine soils were needed to make a stable blend. A sample of the sandy soil is placed in a cup 3-3/16" high by 3-1/16" inside diameter and loaded to failure under a bearing plate one square inch in area. The soil specimen is prepared by mixing 600 grams of the sample with 10-1/2 c.c. water, then compacting it in the cup with a 3" diameter bearing plate under a total pressure of 1200 lbs. Pressure on the bearing plate is increased at the rate of 1 lb. in 7-1/2 seconds, until it is great enough to cause a deformation of 0.1 in 5 seconds, at which point the measured load is considered as the bearing value of the soil.

### SPECIFICATION REQUIREMENTS

The test is used not only for the sand-asphalt mixtures, but also in controlling the subgrade which is stabilized to a depth of 12" below the pavement. This varies from 30 lbs. for light traffic to 60 lbs. for heavy duty projects. The sand-asphalt pavement is placed to a uniform compacted thickness of 6" and soils suitable as aggregate, either as found naturally or blended, will have values ranging from 40 to 90 lbs. Values above the latter amount indicate excess fines which would require so much asphalt that a gummy mix would result. The quantity of asphalt varies according to the percentage of fines present, and will range from 4% to 7% asphalt cement in the mix as finally cured and compacted.

These pavements are not only economical in first cost but maintenance costs are also very moderate. The first project constructed in Florida was not resurfaced until eighteen years later, when it was widened and resurfaced with 1-1/2" of asphaltic concrete. This pavement today carries over 3,500 vehicles per twenty-four hour period, many of them heavy trucks. Other installations have been in service for periods of thirteen years with only one extra sand seal needed to renew the surface. These roads are exceptionally smooth riding and the procedure is adaptable wherever sandy soils are naturally abundant.



Loading distributor from tank car through oil heater.



Stock-piled pea gravel for spreading over surface as cover.



Application of pea gravel over old oiled earth surface.

## OILING EARTH ROADS IN ILLINOIS

In the cornbelt or central portion of Illinois, local deposits of aggregates are limited and the success of using road oil and its acceptance by the public as a quick and economical way of getting out of the mud was recognized as early as 1910. Now, after forty years, road oiling is still preferred as the economical method of maintenance or stage construction and is generally used where the volume of traffic is less than four hundred vehicles per day. The quantity of road oil required annually in Illinois for this purpose totals about forty million gallons.

### ROAD PREPARATION FOR OILING

Preparation of a road for oiling usually is started in the spring. Excess soil is bladed from the ditches over the roadway and worked until all clods are broken up. The road surface is shaped to a uniform cross-section having a crown of about one-fourth inch per foot of width of the roadway. Where excess vegetation is encountered it is removed. After the roadway has been bladed to proper crown it is compacted under traffic and smoothed frequently with light maintainers. Where considerable dust is encountered on the roadway it is removed before applying road oil because dust acts as an insulating course and prevents proper penetration of the road oil. Dust is generally removed with a motor grader and is bladed uniformly over the shoulder of the road.



Showing surface texture of earth road, north of Prouty, Illinois, after several annual applications of road-oil.

### APPLICATION OF ROAD OIL

Before road oil is applied it is heated to a temperature of 150° to 200° F. so that a uniform fan-shaped spray will be obtained when it is applied from the distributor nozzles. At first, heating was accomplished with portable steam boilers, but fuel oil heaters have largely taken their place. On township roads with traffic of less than 100 vehicles daily, the oiled width is usually from 10 to 12 feet. On country roads it may be from 20 to 24 feet, in which case one lane is oiled at a time. Traffic is kept off the treated surface until the oil has penetrated and cured, as a cover coat is seldom applied for light traffic roads during the first three years. Application the first year is at the rate of 0.4 to 0.6 gallon per square yard, the second year two treatments may be given, one in June, the second in July or August, averaging 0.5 and .25 gallon per square yard respectively, while the third year a single treatment of 0.4 to 0.6 gallon is again made.

Before each season's treatment the road surface is usually scarified, brought to the proper crown and compacted before the retreatment is made. After the third year's

treatment much of the top 3 or 4 inches of roadway soil has become waterproofed with road oil and, where soil conditions are favorable, many of the County Engineers then are constructing a surface treatment in the following manner:

The oiled road surface is scarified to a depth of 2 or 3 inches and this material is bladed into a windrow. With Pulvi-Mixer the windrowed material is then pulverized or shredded to disperse properly the old road oil in the soil. When this is accomplished the blended mixture is bladed uniformly across the road surface to proper crown and cross-section. After proper compaction under traffic, the surface is then primed with 0.2 to 0.3 gallon per square yard of a light road oil. When the prime coat has cured properly 0.2 to 0.3 gallon either of asphalt MC-5, SC-5 or SC-6 is applied per square yard as a seal coat. Immediately after applying the seal coat 20 to 25 pounds pea gravel are spread over the surface as cover.

The average annual cost of road oil treatments for the first three years is about \$600 per mile 20 feet wide; with the heavy surface treatment construction cost at about \$1,000 per mile.

# ASPHALT INSTITUTE ENGINEERS

## WALTER F. WINTERS



Walter F. Winters, formerly Special Projects Engineer at the Denver Office, was promoted as of September 1st to be Chief Engineer of the Institute. Mr. Winters' training for this post includes the Engineering course at Washington State College, with supplementary courses at the University of Virginia and Northwestern University, followed by a career of nineteen years of county, city and state engineering experience in the State of Washington, and six years of outstanding military service here and overseas from 1940 to 1946.

Mr. Winters, as Chief Engineer, assumes direction nationally of a rapidly-growing staff, promoting the use of asphalt for roads, streets and airfields, and developing requisite research for these and additional uses.

## JOHN R. BANNING



With headquarters at 1250 Stout Street in Denver, Colorado, John R. Banning extends the Institute's engineering facilities for the promotion of asphalt throughout the states of Colorado, Idaho, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, and Wyoming.

Mr. Banning, fifth in years of service on the Institute's Divisional Engineering staff, served nineteen years with the City and County of Denver, of which six years were with the Engineering Department, four years as Bituminous Engineer and Assistant Superintendent of the Paving Division, and nine years as Highway Commissioner. Mr. Banning's engineering experience also includes three years as Project Engineer with the U. S. Bureau of Public Roads in Yellowstone Park highway construction.

## EDWARD M. HOWARD



Edward M. Howard, from his headquarters at 25 Huntington Avenue in Boston, directs local engineering activities of the Institute throughout the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

Mr. Howard, sixth in years of service on the Institute engineering staff, attended Dartmouth College and is a graduate of the Massachusetts Institute of Technology in civil engineering. He began his career in highway engineering with the Illinois Division of Highways in 1921 and possesses a broad experience in highway and airfield construction. Just prior to coming with the Institute he was Engineer of Design with the U. S. Bureau of Public Roads at Indianapolis. Mr. Howard, a veteran of World Wars I and II, served during the latter with the Seabees.



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